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PRESENT STATUS AND CONTEMPLATED DEVELOPMENT OF PESTICIDES PRODUCTION IN INDIA 1/

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PART I

PRESENT STATUS AND CONTEMPLATED DEVELOPMENT OF PESTICIDES PRODUCTION IN INDIA

1. Products Manufactured

1.1. The general term 'Pesticides' includes Insecticides, Fungicides, Rodenticides, Molluscicides, Nematocides, and Weedicides.

1.2. The basic manufacture of pesticides commenced in India in 1952 by setting up a plant for the manufacture of Benzene Hexachloride (BHC) which was followed by DDT. Among the South Asian and African countries, excluding Japan, India is the largest manufacturer of basic pesticidal chemicals. Currently, under various categories, the following pesticides are being produced indigenously:

INSECTICIDES: Aluminium phosphide, BHC, Chlorinated terpene, DDT, Dichlorvos, Dimethoate, EDCT Mixture, Ethylene dibromide, Fenitrothion, Lime Sulphur, Lindane, Malathion, Methyl bromide, Nicotine sulphate, Oxydemeton-methyl, Parathion (ethyl), Parathion Methyl), Phosphamidon, Pyrethrum extract, Thanite, Toxaphene.

FUNGICIDES:	Aureofungin, Barium polysulphide, Copper oxychloride, Cuprous oxide, Ferbam, Mancozeb, Nickel chloride, Organo mercurials, Sulphur colloidal, Wettable and Dust, Streptocycline, Thiram, Ziram, Zineb.
RODENTICIDES:	Coumafuryl, Warfarin, Zinc phosphide.
MOLLUSCICIDE:	Metaldehyde.
NEMATOCIDE:	Methan N Sodium.
WEEDICIDES:	Ammonium sulphamate, 2,4-D, 2,4,5-T.

1.3. Most of the above mentioned pesticides are being produced in the Organised Sector, the exception being Nicotine Sulphate. The technology for the development of Pentachloro Nitrobenzene and a Weedicide - Simazine - has also been perfected, but the commercial production is yet to commence. An important insecticide known as 'Monocrotophos' may come into production very soon. Manufacturing licence/Letters of Intent have been issued for some new products; for details of which refer to Annexure I.

1.4. Demand of individual pesticides, assessed by the end of 1973-74, and production achieved during the year 1971 is given in Col. 3, Annexure I. So far 52,314 tonnes

capacity for the production of various pesticides has been licensed, out of which 44,670 tonnes capacity is installed.

There are 18 units manufacturing technical materials and 37 units manufacturing formulations, which are in the organised sector. There are about 110 units in the Small Scale Sector which mostly undertake the manufacture of conventional formulations, mainly dusting powders, and to a limited extent, wettable powders and emulcifiable concentrates.

1.5 It is estimated that in 1971 about 136,000 tonnes of formulations were sold; the market value thereof being about Rs. 440 millions. The quantity and value of pesticides produced by the organised sector during the year 1971 are given below:

Technical material	23,736 tonnes	(Rs. 92.5 million)	
Formulations: Solid	43,578 tonnes	}	(Rs.300 million)
Liquid	9,789 tonnes	}	

2. Steps taken by the Government to develop the industry

2.1. Unlike fertilisers, most pesticides cannot be used in their commercially pure form and have to be formulated in a ready-to-use preparation as dusting powders, water dispersible powders, emulsifiable concentrates, solutions and granules. The pesticides industry in India came into existence first by the manufacture of formulations from imported technical materials, and, as the demand increased, basic manufacture commenced. The subsequent development of the industry has been possible through certain major steps taken in this respect by the Government as outlined below:

- Production of pesticidal chemicals has been included in the Core Sector for Licensing under the Industries (D and R) Act.

- For the purposes of import of raw materials, this industry is listed under priority industries and is also eligible for import under IDA Credit.

- To develop and sustain the formulation industry, pesticides are allowed to be imported preferably only in commercially pure form.

- To make available the various formulations to farmers at a reasonable cost, customs duty on import of some selected pesticides and chemical raw materials, to encourage a basic manufacture has been reduced to 10% ad-valorem.

- Banning the import of pesticides being manufactured in India, and restricting the import of items competing with the indigenously produced materials.

- Supply of indigenous raw materials and allotment of tank wagons for the transportation of these chemicals to the industry is arranged on priority basis.

- To regulate the import, manufacture, sale, transport, distribution, and use of insecticides with a view to prevent risk to human beings or animals, the Insecticides Act has been introduced.

2.2. Despite the above measures, there has been under-utilisation of installed capacity for some of the items like BHC, Copper oxychloride, Thiocarbamate, Dithiocarbamates and Weedicide (2,4-D), mainly due to the present poor off-take. The existing capacities for thiocarbamates and dithiocarbamates are being progressively better utilised and the demands are consistently rising. The demand for more effective pesticides like organo-phosphatic compounds whose capacities are already being utilised adequately, is increasing.

3. Targets and Consumption for the period ending 1973-74.

3.1 According to the targets set forth by the Planning Commission, 80 million hectares were to be covered within this period requiring the use of 62,000 tonnes of technical pesticides, of which 53,500 tonnes were expected to become available through indigenous production, and 8,500 tonnes through imports.

3.2. The coverage under plant protection was to be achieved by the following components, and target for each as fixed originally and the likely achievement by 1973-74 is indicated below:

	Target 1973-1974 (in mill hectares)	Likely achievement 1973-1974 (in mill. hectares)
i) seed treatment	24.00	11.00
ii) general pest control and intensive treatment .	39.50	41.00
iii) rodent control	14.00	6.00
iv) weed control	2.50	2.00
	80.00	60.00

3.3 From the above, it is obvious that the likely achievement by the end of 1973-74 will be lower than the target. To achieve the target of 60 million hectares by 1973-74, 44,940 tonnes of pesticides will be required (Indigenous 36,000 tonnes and Imported 8,940 tonnes). During 1971-72, the actual consumption of pesticides has been about 30,000 tonnes covering 37.5 million hectares which may rise to 35,160 tonnes in 1972-73, sufficient to cover about 45.5 million hectares. While the progress is reasonably satisfactory in respect of General Pest Control, Intensive Treatment and Weed Control, there is likely to be a short fall in respect of Seed Treatment and Rodent Control, despite the fact that the pesticides needed for these are available in sufficient quantities from indigenous sources.

3.4. Besides protecting the standing crops by prophylactic and curative treatment, pesticides also play an important role in post-harvest technology by preventing and suppressing infestation by insects and rodents. No targets for this were indicated in the Fourth Plan. Scientific storage of harvested produce is so far confined to organised institutions like Food Corporation of India, and the National Warehousing Corporation, Co-operatives, etc. It is estimated that, on average, 6-8% of the harvested produce is lost on account of ravages by pests. More than 70% of the country's production is stored at the farmers' level where the knowledge of scientific storage is practically non-existent. Realising this deficiency, the Ministry of Agriculture has recently initiated a "Save Grain Scheme". Pesticides needed for post-harvest use are indigenously available in adequate quantity.

3.5. Fertilizers and pesticides are complementary inputs, the greater use of the former leads to the latter. In countries having high agricultural productivity, the cost-wise ratio between fertilizers and pesticides is 3.5:1.0. In India the use of these two inputs is very meagre, but even so that cost-wise ration is aroud 7:1. The consumption of pesticides vis-a-vis fertilizers in India is lagging behind the accepted norms. In 1963-64, for every kg. of plant nutrient 19 grams of pesticides (technical) were used and in 1971-72 this figure has come down to 13 grams. The imbalance needs to be rectified in the Fifth Plan especially when the consumption of plant nutrient is expected to rise from 22 kg./ha. in 1973-74 to 50 kg./ha. in 1978-79. It is significant that in 1954-55 the consumption of pesticides was 3.2 gm/ha. which in 1968-69 rose to 170.4 gm/ha and in 1973-74 the estimated target - excluding fumigants - is 336 gm/ha. (In Japan it is about 10,000 grams; U.S.A. and West European countries about 2,000 grams).

3.6. The crop plants in India are affected by over 250 pests and diseases of economic significance. Specificity of a pesticidal chemical has a special significance in crop protection programmes. Because of this fact, consideration of the overall installed capacity of the industry or its under-utilisation has little relevance to the demand pattern. For example, the large installed capacity for the weedicide, 2,4-D or for most fungicides cannot be put to use to control insect pests; weedicides cannot control diseases nor fungicides the weeds. Furthermore, almost 40% of the installed capacity is accountable to Benzene Hexachloride (BHC) which cannot

effectively control many insect pests or produce liquid formulations which are becoming increasingly popular. The installed capacities of many effective insecticides, e.g. Parathion,Metasystox, Dimethoate, Malathion, Fenitrothion, etc. are now not adequate to meet the current needs.

3.7. It has, therefore, become necessary to import a variety of pesticidal chemicals, most of which fall under the classes 'Insecticides' and 'Weedicides'. Due care has been taken to avoid indiscriminate proliferation of the products not only to protect the interest of the Indian industry but also to encourage the manufacture of newer, safer and better products.

3.8. In recent years, the demand for pesticides has increased considerably because of the extension of coverage under endemic and epidemic area schemes of the Ministry of Agriculture to protect the food and cash crops, and on account of initiation of the crash programmes on many cash crops especially cotton, oilseeds and jute. The additional requirements have been met by importing technical material for formulating it in the country wherever the facilities exist. Firms which came up to carry out this work were allowed to import the required technical material on the basis of formulation facilities available with them. Those firms which had proposed basic manufacture of these materials and had carried out field trials and market promotion of the formulations concerned, and were thus able to guide the farmers in the use of their products were given preference. To encourage healthy competition, other formulators were also allowed to import these pesticides also for formulation within their overall capacity.

3.9. To benefit by the use of new products of research and development carried out in developed countries, and to identify their suitability for use under local conditions, it was considered essential to carry out field trials. Import of certain pesticidal chemicals was, therefore, permitted for trial purposes. Such trials were undertaken by firms with facilities and technical know-how of their usage, preference being given to firms with proposals for basic production after studying their usefulness and market potential.

3.10. In this connection, in 1971-72 a total foreign exchange of Rs. 102.45 million was allocated for the import of raw materials to the pesticides industry in the Organised Sector with its break-up as under:

Value of raw materials for manufacture of technical material.	Rs 18.68 million
Value of technical material for formulation	Rs.83.77 million
	Rs.102.45 million

(The corresponding figure for 1973-74 will be Rs. 23.7 million and Rs. 166.7 million respectively. Information in respect of small-scale sector is not available.)

4. Extension Education and the Promotion Work.

4.1. Efforts to educate farmers on the use of pesticides are being made by the industry, State Departments of Agriculture, Agricultural Universities and the Indian Council of Agricultural Research through the regional and national demonstrations, by farmers training schemes, and also by the audio-visual programmes of the All-India Radio. These measures do not appear to have produced the required impact. Unlike fertilisers, the use of pesticides is more complicated because it needs some training to identify the pests, to select appropriate pesticides, to use it in a required quantity and at the right time. It is, therefore, understandable that the usage of pesticides in the country continues to be at a very low level and quite disproportionate to the quantity of fertilisers used. The message behind the new agricultural strategy and the concept of adoption of package of practice has yet to percolate to the Village Level Extension Worker who is the ultimate vital link at the farmer's level. The non-fulfillment of the target and the unutilised capacity of the industry can be attributed to the poor quality of the extension efforts and it needs to be reoriented if the targets set forth for the Fifth Plan are to be achieved.

4.2. As a result of meticulous screening, booked by the educational extension efforts, the products are taken up for market promotion by the industry as well as by agricultural

departments, co-operatives and the agro-industries corporations. This effective promotion work can, therefore, be done primarily by those who are well equipped with the field organisations and are in a position to render technical advice to the farmers. This facility, at present, is available only with the industry and not with others who are mainly concerned with the distribution of inputs.

4.3. The demand pattern of the industry has also changed with certain signs of resistance developed by the pests to some insecticides after long usage, as also due to the problems of pollution created by the persistent residues left behind by certain insecticides like chlorinated Hydrocarbons. Thus, accent is being increasingly accorded to those which leave less residues like Organo Phosphates and Carbamates etc. in place of those which leave considerable residues.

PART II

APPROACH TO PERIOD 1973-74 TO 1978-79

(Vth Plan Period)

2.1. Introduction

2.1.1. The pest/disease complex of crop plant is not static and keeps changing with the pattern and intensification of cropping. This is not only true of India but also of other countries. There is also a growing consciousness in most countries of the problems of pollution and the adverse side effects of pesticides by way of contamination of environment and toxic residues left by them on crops. Over 900 pesticides are being marketed in the world. To be able to produce pesticidal chemicals economically in the country and of desirable attributes, the number of items should be restricted and any trend for indiscriminate proliferation of items should be curbed. Even in the past, attempts have been made to limit the number based on schemes where basic manufacture of the items has been forthcoming from the manufacturers, and only those products were allowed to be promoted for use.

2.1.2. The requirement of various classes of pesticides given in ANNEXURE II has been estimated keeping in view the following factors:

i. To achieve the targets of plant protection as proposed by the Ministry of Agriculture and expected pest/disease situation.

ii. The existing and the proposed production capacity for various pesticides in the country.

iii. The likely development of basic chemicals in the country and the proposals for research and development.

2.2. Demand pattern during 1973-74 to 1978-79

2.2.1. According to the Ministry of Agriculture, the coverage for plant protection would be 100 million hectares (gross) at the end of the Fifth Plan with the following break-up:

a)	Seed Treatment	-	21.0 million hectares
b)	Rat Control	-	12.0 " "
c)	Weed Control	-	4.5 " "
d)	Intensive Treatment on surface and soil pests	-	62.5 " "
			100.0 " "

2.2.2. For a crop-wise break-up of these targets, refer to ANNEXURE III.

2.2.3. The total requirement of pesticides for 1978-79 for agriculture has been estimated at 77,420 tonnes comprising about 100 different pesticidal chemicals. The year-wide requirement of different pesticides is given in ANNEXURE II.

2.2.4. For facility of reference, the products have been indicated under different heads, namely, Insecticides, Acaricides, Fungicides, Antibiotics, Weedicides, Rodenticides, Nematocides, and Fumigants.

2.2.5. Based on chemical composition the pesticides fall under the following groups:

i. Chlorinated hydrocarbons.
ii. Organo phosphates.
iii. Carbamates and their thio salts.
iv. Metallic salts.
v. Weedicides (belonging to various chemical groups).
vi. Fumigants.
vii. Rodenticides, and
viii. Misc. New Products (various classes of pesticides of different chemical groups).

2.2.6. The main characteristics of these are discussed below:

<u>Chlorinated hydrocarbons</u> - (like Aldrin, BHC, Chlordane, DDT, Dieldrin, Endrin, Endosulfan, Heptachlor, Lindane, Toxaphene)

leave residues and may cause problems of pollution. But since capacity wherever installed for the production of any of these pesticides has to be effectively utilised and these products are comparatively cheap, their use will have to continue in certain limited spheres. Availability of chlorine, and cyclopentadene in the near future for the production of these pesticides and their usefulness as soil insecticides and their long residual action, which is needed in certain situations, are also factors in favour of their continued use. However, use of products which are not yet produced and are definitely known as serious pollutants like Endrin will have to be gradually discouraged as and when indigenously produced substitutes become available.

Organo phosphates - The basic raw materials required for the production of this group of chemicals are phosphorous pentasulfide and phosphorous trichloride and both are produced indigenously. They also leave less persistent residues on the crops as compared to the chlorinated hydro-carbons. Efforts have, therefore, been made to assess their demand on the basis of trials and market promotion already done in the country for such chemicals.

Carbamates and Thiocarbamates - These also do not leave persistent residues and are good substitutes of chlorinated hydrocarbons and metallic salts. With the production of such pesticides in the country, valuable foreign exchange required for the import of scarce metals like copper, mercury, nickel etc. could be saved.

Misc. New Products - (like sophisticated weedicides, nematocides and systemics) The modern trend is towards encouraging the use of new chemicals having many desirable features, combining high pesticidal efficiency with other qualities like low toxicity to man and

cattle, safety for bees and fishes, more selective in action and quick biodegradation on treated surfaces and soil. Systemics, often incorporated in soil as granules, are absorbed and translocated into the plant tissues and distributed to various parts of the plants in quantities sufficient to kill the pest/pathogens. The latest development in the field of chemical control is of introducing physiological disorders in the insect body by using chemo sterilants, juvenile hormones, etc. To get the benefit of research and development carried out by developing countries, it is essential to carry out trials and market promotion in the country to assess the demand before a manufacturing plant of economical size could be proposed for their production. Assessments of such demands have, therefore, been included under 'experimental and miscellaneous new products'.

2.3. Ways of Securing Objectives

2.3.1. Extension efforts needed to promote the use of pesticides.

In the new agricultural strategy, use of pesticides has acquired a significant place for boosting production along with improved seeds, fertilisers and irrigation. The rapid change in the cropping patters necessitated by the adoption of various programmes has brought many new challenges for the supply and use of the pesticidal chemicals. There is now greater awareness and enthusiasm among the farmers to take to chemical control of pests and diseases, as a result of the continuous efforts made by the State Departments of Agriculture and by the Industry.

2.3.1.2. The pesticides which are being used by farmers are grouped into two categories, i.e., pesticides produced locally and pesticides imported from outside. There are about 42 different pesticides being produced in the country and another 60 are being imported to cater to the needs of farmers. It has been observed that in spite of making such a wide variety of pesticides available to farmers, the consumption remains very low. The extension efforts by the State Governments alone will not be sufficient to meet the problem , and promotional effort by the pesticides industry is most essential. The number of pesticides being introduced in the country is gradually increasing and it is necessary to arrange trials in the farmers' fields, not only to convince him about the efficacy of pesticides but also to show their superiority and safety effects. It has been observed that a large range of pesticides without proper promotional work tends to create confusion in the minds of farmers.

2.3.1.3. It should be obligatory on the part of the industry to arrange with the help of field force demonstrations to convince the farmers not only about the benefits but also the cost benefit ratio. With the gradual withdrawal of the State Governments from the trading activity, it has become all the more necessary for the pesticides industry to take up the promotional work and distribution of pesticides at the farmers' door by opening more sale points.

2.3.1.4. In the past, the emphasis of overall development effort was, to a large extent, on areas of maximum promise of agricultural growth and the farmers in these areas have readily come forth to adopt plant protection practices.

Agriculture in the rain-fed areas presents a more formidable problem where, because of low yields, poverty is acute and wide-spread. While in the Fifth Plan intensive agriculture programmes, such as multiple cropping and extending area under high yielding variety programmes, will continue to receive attention, special efforts will be made to raise the productivity in the rain-fed and other less promising areas. Pilot projects and intensification of research in dry farming technology and pilot project for testing new technology have also to be initiated. The new technology is useless unless farmers know how to use it and are willing to do so.

They must be brought into educational process in an appropriate and realistic manner. The optimisation of productivity through the use of fertilisers in this sector (estimated to currently constitute some 60% of the arable area) is limited due to insufficiency of rainfall and/or irrigation. It is well known that such areas have their own special pest and disease problems of serious magnitude. In the Fifth Plan therefore, extension work of plant protection should receive special attention.

2.3.15. To begin with, simple plant protection measures which require little skill or equipment, like seed treatment and rodent control, should be extensively propagated. Additionally, it would be profitable to arrange large scale demonstrations of foliar spraying of the urea solution mixed with pesticides so as to get dual benefit in such vulnerable areas. The efficacy of this technology has been amply demonstrated over large areas on wheat, rice, cotton, jute, etc.

2.3.2. Surveillance Service

2.3.2.1. This service was introduced in a small way on a regional basis. It is necessary to rapidly expand its network to help agriculturists by communicating to them intelligence about the progressive development of pest population or diseases. It must be remembered that plant pests and diseases do not suddenly break out without any preliminary warning. It is for the surveillance service to perceive the developing situation by obtaining accurate and timely seasonal reports and other information and interpret such data in the light of accumulated experience with a view to issuing necessary warnings of pest and disease outbreaks. Reliable reports about the periodic rise and fall in the incidence of insect pests and plant diseases for different localities and corresponding weather data play an important role in communicating accurate warning about imminent outbreaks and epidemics so as to initiate timely action for their control. Such a service will reduce the requirements of pesticides as compared to measures undertaken after an epidemic has set in.

2.3.3. Licensing Policy

2.3.3.1. With the increasing use of pesticides, the pattern of usage of different formulations is changing rapidly from dusting powders to more sophisticated wettable powders, emulsifier concentrates (for high and low volume application) granules, etc. Newer formulations, like foam application, have been developed in the USA, which considerably reduce the

pollution and increase efficacy of pest control. All this will require considerable development work and tighter quality control. Therefore, care must be taken to licence capacity to only those formulators who not only are competent to formulate according to specifications but can also provide adequate safety measures to the workers.

Manufacturers of new pesticides or special patented products are usually unwilling to make available technical material to outside formulators. Keeping in view all the aforesaid factors, Government has approved a formulation policy categorising various pesticides as given below:

Category I: Pesticides like BHC, Aldrin, Chlordane, Carbaryl, DDT, Dieldrin, Ferban, Heptachlor, Malathion, Parathion, Thiram and Ziram. 50% of the production of these pesticides would be reserved for distribution to other formulators.

Category II: Pesticides like Captan, Dometon, Lindane, Phorate. 25% or higher, if possible, production of these pesticides would be reserved for other formulators as the markets for such products are small and uncertain.

Category III: For new products covered under patents, the policy for reservation to other formulators for such products should be flexible, as a great deal of work may have to be done to work out appropriate formulations for the conditions prevailing in the country.

2.3.3.2. In view of the above, it is not desirable to reserve any type of formulation to any particular sector. It is only with healthy competition and R and D work in the field that the newer types of formulation will become available to the farmers. In the interest of rapid extension of pest control measures, it will be necessary to ensure:

i. that the idle capacity lying with the existing formulators is utilised to the full extent.

ii. that the seasonal demand of particular pesticide is set in time.

iii. that development and market promotion is encouraged by such parties who have technical competence, know-how and facilities for carrying out such work.

iv. that the parties who have proposals for production of such chemicals in India, starting from basic raw materials available locally, are encouraged.

v. that the newer products which have many advantages over the existing ones with regard to toxicity, safety, price and effectiveness are introduced.

2.3.4. Registration of Pesticides under Insecticides Act

2.3.4.1. With the enforcement of the Insecticides Act and Rules, regulatory control on the production and use of pesticides is being introduced. As regards the guidelines laid down by the Central Insecticide Board on toxicological

aspects, the Board has not favoured the open door policy adopted so far in the licensing for manufacture in the light of recent evidence of the harmful side effects of pesticides on the human environment. The policy served a useful purpose in the early years when the industrial base was too narrow. Now that some 42 pesticides belonging to different groups are produced and many more will be made in the country, a rational policy is being adopted by introducing safer pesticides and also alloting the diversification of the existing units so that they change over to newer and safer pesticides.

2.4. Raw material requirement and foreign exchange component

2.4.1. The main raw materials required per tonne for the manufacture of different major pesticides is given in ANNEXURE IV. Foreign exchange requirement for the import of raw materials and pesticidal chemicals require to supplement their availability from indigenous sources are given in ANNEXURES V and VI. It is estimated that by the end of 1978-79 the total foreign exchange requirement for import of raw material would be about Rs. 80 million. However, if raw materials like paranitrophenol, maleic anhydride, and amines become availbble locally as per production programmes undertaken for these items by the chemical industry, the foreign exchange requirement for raw materials would be reduced to about Rs. 55 million. It is estimated that by this expenditure the country will be able to save crop losses due to pests to a substantial extent estimated at about Rs. 4,000 million.

2.5. Formulations

2.5.1. Many pesticides have to be formulated with the required concentration of the toxicants. This involves compounding inert ingredients with active pesticides (toxicant) to make a composition which is easy to apply, active, stable and free of undesirable side effects. While in most cases formulations are produced out of individual pesticides, in some cases combination of two or more toxicants is used to increase the biological efficacy. Combination of small quantities of high toxicity pesticides with one of lower toxicity is known to have the same biological efficacy. Investigations in this direction should be undertaken so as to minimise the use of highly toxic pesticides.

2.5.2. Manufacture of a good formulation needs various considerations, specially the interaction between pesticides with the inert materials - clays (its absorptive capacity, particle size, etc.), solvents, emulsifiers, wetting, dispersing, and anti-caking agents, and stabilisers. The interaction of spray formulations with target and finally the rate of biodegradation are also requisite for proper formulation. The aim is not only to disperse the toxicants evenly but also to see that it reaches the target with maximum biological efficiency and also not phytotoxic. Selection of proper solvents and additives to increase the deposition, wetting and prevention of their volatility and leaching, all have to be thought of for ensuring a good formulation.

2.5.3. In India formulation research for pesticides is in its infancy and no comprehensive programme has yet been drawn up to tackle the problem on lines mentioned above.

2.5.4. Along with facilities for formulations research, it is also necessary to have a well-organised self-sufficient testing bio-assay and toxicology unit to carry out a wide spectrum screening of the pesticidal formulations. The work of the units that do exist for this purpose has to be properly co-ordinated.

2.5.5. Synergists:

Synergists are chemical substances which, at levels non-toxic by themselves, markedly increase the toxicity of the pesticides when applied with it in joint action. In advanced countries, attempts have been successfully made to reduce the quantity of toxicants and improve the biological efficacy by the use of synergists. At present in India Piperonyl Butoxide is used with Pyrethrum extract. At least 6 other chemical compounds having synergistic activity are known which could be used with chlorinated hydrocarbons, phosphatics and carbamates, some of which are fractions of sesame oil.

2.5.6. Pesticides of Botanical Origin:

In view of the problem of pollution and associated toxic hazards on account of residues on treated crop plants, many advanced countries have started giving increasing attention to the use of insecticides of botancial origin, notably those derived from pyrethrum flowers, tobacco waste, and Derris, which were widely used before the introduction of synthetic organic

insecticides. Their consumption declined because of their relatively high cost. There is a need to revive their use by providing necessary incentives. There are good possibilities of cultivating pyrethrum in India. Likewise, large areas are under tobacco cultivation and sizeable quantities of raw materials in the form of waste are available. Derris can be cultivated in forest areas and its alkaloid fraction , rotenone, has very good insecticidal properties. Apart from encouraging domestic use, these should have good export potential, especially in Japan, USA and European countries.

2.6. Requirement of capital equipment

Keeping in view the recent trend in the use of modern sophisticated pesticides and their estimated demand during 1973-74 to 1978-79, major investment in capital equipemnt is estimated for the production of Organo-phosphates , Carbamates and Weedicides. The capital goods required for the production of pesticidal chemicals (tech. material) is more or less the same as for other sophisticated organic chemicals. ANNEXURE VII gives the kind of materials and their equipment that are or will be needed. By the end of 1978-79, the additional investment on plant equipment is estimated at Rs. 386.6 million, the details of which, with the break-up of the value of indigenous and imported components, are given in ANNEXURE VIII.

2.7. Pesticides application equipment

With the increasing emphasis on agricultural production, this industry has assumed great importance. The production of agricultural sprayers and dusters, both manual and power operated, has shown a rise; for example, for the units in the organised sector, the value has gone up from Rs. 24.6 million in 1970 to Rs. 34.3 million in 1971. The manufacture of manual sprayers and dusters has been reserved for small scale sector in which more than 50 units are engaged. The Indian Standards Institution has laid down the Indian standards specifications for such types of equipment which are in popular use. A notable progress has been made, in so much so that scarce ferrous and non-ferrous metals are being progressively replaced by models with plastic and nylon components.

2.8. Manpower requirements and employment potential

2.8.1. It has not been possible to assess the technical manpower required of different categories. Nonetheless, the industry has experienced no difficulty so far in securing the services of technical, skilled and semi-skilled man-power, to run the established plants. However, for erection of newer plants to produce sophisticated pesticides and to operate them, training facilities for Indian personnel, under the guidance of foreign experts, needs to be enlarged.

2.9. Infra-structure requirements (electricity, water, fuel, etc.)

2.9.1. It has not been possible to assess these requirements. However, these are insignificant because of the present small size of the industry. The production will also not make any heavy demand on the transport facilities. Except for dusting powders, most other formulations are moved by road transport. About 0.35 million tonnes of formulations will have to be transported by 1978-79. Since the demand will be seasonal, and the products essential for agricultural production, special facilities of transport in the peak season will be required.

ANNEXURE I

PRESENT POSITION OF PESTICIDES INDUSTRY
AS ON 31-12-1972

Sl.No	Name	1973-74 demand	Capacity licensed	Capacity installed	Capacity under consideration LI issued	Production 1971
1.	BHC	52,000	28,900	25,900	8,640	15,429
2.	DDT	15,000	4,200	4,200	-	4,116
3.	Aldrin/Dieldrin/ Chlordane/hep-tachlor	1,000	-	-	-	-
4.	Endrin	3,500	-	-	-	-
5.	Carbaryl	3,000	2,000	-	5,000	-
6.	Endosulfan	750	-	-	3,600	-
7.	Toxaphene	1,000	250	250	1,000	-
8.	Malathion	3,500	2,300	1,700	4,000	819
9.	Parathion	3,200			500	602
10.	M. Systox	*	1,200	1,200	-	46
11.	Fenitrothion	2,000			500	43
12.	Dimethoate	*	220	220	-	188
13.	Phosphamidon	*	636	636	-	-
14.	DDVP	300	276	276	-	-
15.	Phorate/Formo-thion/Disyston/ Thiometon/ Quinalphos, Mono-crotophos	5,000	-	-	500	-
16.	Al. Phosphide	400	450	250	330	178
17.	EDB/EDB	300	960	608	-	72
18.	Morocide/Tedion	400	-	-	-	-
19.	Copper oxychloride	2,300	2,284	2,284	-	865
20.	Nickel chloride	400	150	150	-	46
21.	Thiocarbamates	10,000	4,684	3,700	-	1,120
22.	Dithiocarbamates	1,200	850	850	-	24
23.	Dicofol	500	-	-	-	-
24.	Organomercurials	60	111	86	-	12
25.	Weedicides	6,000	2,485	1,860	9,940	350
26.	Nematocides	500	-	-	-	-
27.	Rodenticides	700	350	350	-	195

* demand included in item 15, assessed earlier by the Pesticides Panel.

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ANNEXURE II

ESTIMATED DEMAND OF PESTICIDES IN FIFTH PLAN

(in tonnes)

Name of Pesticides	PENULTIMATE YEARS OF FOURTH PLAN		FIFTH FIVE YEAR PLAN					REMARKS
	1972-73	1973-74	1974-75	75-76	76-77	77-78	78-79	
1	2	3	4	5	6	7	8	9
A. INSECTICIDES								
1. BHC	14,500	18,500	20,000	21,500	23,000	24,500	25,000	Including for Lindane
2. DDT	1,500	3,000	3,400	3,800	4,200	4,600	5,000	Agrl.use only
3. Endrin	800	600	280	220	160	100	80	
4. Aldrin/Heptachlor/Dieldrin	220	220	355	415	475	535	450	
5. Chlordane	80	90	100	110	120	130	140	
6. Endosulfan	400	600	800	1,000	1,200	1,400	1,800	
7. Toxaphene	500	600	700	800	900	1,000	1,200	
8. Carberyl	3,000	4,500	5,000	6,000	6,500	7,000	8,500	
9. Malathion	1,200	1,590	1,980	2,370	2,760	3,150	3,500	Agrl. use only
10. Parathion(ethyl & methyl)	850	950						
11. Metasystox	55	70	1,300	1,650	1,900	2,050	3,000	
12. Fenitrothion	85	115						
13. Dimethoate	220	270	314	361	408	455	500	
14. Phosphamidon	300	350	400	450	500	500	650	
15. DDVP	65	80	120	160	200	240	300	
16. Monocrotophos	100	200	250	300	350	400	450	
17. Phorate	100	125	150	200	300	400	450	
18. Disyston	40	50	50	60	80	100	200	

(in tonnes)

1	2	3	4	5	6	7	8	9
19. Thiodemeton	40	50	70	80	80	100	200	
20. Quinalphos	30	50	70	80	150	200	300	
21. Formothion	20	75	100	125	150	175	200	
22. Cytrolene	50	75	90	90	100	175	250	
23. Thiometon	20	25	30	40	50	75	100	
24. Misc.New Insecticides Carbofuran, Aldicarb, Methomyl, Phosalone, Vamidothion, Phenthoate, EPN, Azinophos methyl, Dicrotophos, Chlorfenvinphos, Phosvel, Padan etc.	160	360	515	715	970	1,220	1,330	
B. FUNGICIDES								
25. Copper oxychloride	650	650	600	650	650	650	650	
26. Thiocarbamates (Zineb, Maneb etc.)	1,500	2,000	2,600	3,200	3,800	4,400	5,000	
27. Dithiocarbamates (Thiram, Ziram etc.)	100	190	280	370	460	550	600	
28. Nickel chloride	50	70	110	120	130	140	150	
29. Org. mercurials (100% mercury)	11	11	12	13	14	15	15	
30. Copper sulfate	3,500	3,500	3,500	3,500	3,500	3,500	3,500	
31. Sulphur wettable	300	400	550	650	750	850	1,000	
32. Sulphur dust	3,000	3,100	3,200	3,300	3,400	3,500	3,500	
33. Other Misc.Fungicides like Benlate, organic tin compounds, Hinosan, PCNB, Vitavax, Plantvax, Fentinacetate etc.	70	140	210	280	360	420	500	

1	2	3	4	5	6	7	8	9
C.	**ANTIBIOTICS**							
34.	Aureofungin & Streptocycline	5	5	5	5	5	5	5
D.	**ACARICIDES**							
35.	Tedion/Morocide/ Ethion/Moresten/ Kelthane	100	110	120	130	140	150	150
E.	**WEEDICIDES**							
36.	2,4-D & 2,4,5-T group	270	350	400	500	600	750	1,000
37.	Paraquat	70	170	270	330	390	450	500
38.	Dalapon	220	250	250	300	500	600	800
39.	Propanil	25	25	50	100	150	200	250
40.	Triallate/Alachlor/ Butachlor/Propachlor	50	150	200	250	500	600	800
41.	MSMA/DSMA	50	100	200	250	500	600	800
42.	Nitrofen(Tok) etc.	150	200	260	320	380	440	500
43.	Experimental & New Herbicides like, Banvel, Probe, Triflurelin Sinbar, Sirmate, Triazines Sub. Ureas and Ammonium sulfamate etc.	100	150	200	250	500	600	800
44.	Plant Growth Regulents Cycocel, Ethephon, Maleic hydrazide, 1 r, Gibberellic acid	25	35	50	100	150	200	200
F.	**RODENTICIDES**							
45.	Zinc phosphide/Warfarin/ Coumafuryl/Cynoduet	170	200	220	250	270	300	300

1		2	3	4	5	6	7	8	9
C.	FUMIGANTS								
46.	Al. phosphide	250	350	450	550	650	850	1,000	
47.	MB/EDB etc.	190	250	350	450	550	650	800	
H.	NEMATOCIDES								
48.	Methem N Sodium/ Terrecur/DBCP/ DD/Telone, etc.	30	40	50	60	70	80	100	
	GRAND TOTAL	35,161	44,941	50,231	57,360	62,962	69,010	77,420	

ANNEXURE III

CATEGORY-WISE AND CROP-WISE BREAK UP OF 100 MILLION HECTARES - LEVEL TO BE REACHED BY 1978-79

(Area in million hectares)

CROP / AREA				AREA EARMARKED FOR PLANT PROTECTION TREATMENT				
	Total Cropped Area		Area under intensive cultivation HYP etc./irrigated	Seed treatment	Rat Control	Weed Control	Intensive Treatment on surface and Soil Pests	
Name of the Crop	69-70	78-79					Net Area - Replication No	Gross area to be treated - sprayed/dusted
1	2	3	4	5	6	7	8	9
1. Wheat	16.60	21.00	12.50	2.00	6.00	1.00	2 - 1	2.00
2. Paddy	37.70	40.00	18.00	6.00	2.00	2.00	18 - 2	36.00
3. Maize	5.90	6.50	1.50	0.50	-	0.25	1 - 1	1.00
4. Jowar	18.60	19.00	3.50	6.00	-	-	3 - 1	3.00
5. Bajra	12.50	13.50	4.50	0.50	1.50	0.25	2 - 1	2.00
	123.50	139.50	40.00	15.00	9.50	3.50	26	44.00
Other Crops			Irrigated area outside HYP					
6. Pulses	22.00	-	3.00	0.50	-	0.10	0.50 - 1	0.50
7. Cotton	7.83	-	3.00	2.00	-	0.25	3 - 2 2 - 1	6.00 2.00
8. Jute	0.70	-	0.05	0.05	-	0.10	0.50 - 2	1.00
9. Potato	0.50	-	-	0.05	-	-	0.30 - 2	0.60
10. Oil Seeds	14.64	-	2.00	1.00	1.50	0.10	2.60 - 1	2.60
11. Sugarcane	2.75	-	2.50	1.40	0.50	0.25	2.00 - 2	4.00
12. Tobacco	0.42	-	0.10	—	—	0.10	0.40 - 2	0.80
13. Other crops			4.35	1.00	0.50	0.10	1.00 - 1	1.00
Fruit and Plantation crops & Vegetables			15.00	6.00	11.50	1.00		18.50
GRAND TOTAL :			55.00	21.00	12.00	4.50		62.50 = 100 Million hectares

ANNEXURE IV

RAW MATERIALS FOR 1000KG OF INSECTICIDE

Name of the Insecticide	Main Raw Materials	Qty. for 1 Ton
1. BHC	1. Benzene	300 Kgs
	2. Chlorine	800 "
2. DDT	1. Chloral	400 "
	2. Chlorobenzene	450 "
3. PHOSPHAMIDON	1. Dichloroacetamide	700 "
	2. Trimethyl Phosphite*	415 "
4. DDVP	1. Chloral	500 "
	2. Trimethyl Phosphite*	500 "
5. COPPER SULPATE	1. Copper	240 "
	2. Sulfuric Acid	400 "
6. COPPER OXYCHLORIDE	1. Copper	580 "
	2. Hydrochloric acid	400 "
7. NICKEL CHLORIDE	1. Nickel	250 "
	2. Hydrochloric acid	1000 "
8. 2,4-D ACID	1. 2,4-Dichloro phenol	800 "
	2. Monochloroacetic acid	450 "
9. ALUMINIUM PHOSPHIDE	1. Aluminium	500 "
	2. Phosphorous Red	550 "
10. ZINC PHOSPHIDE	1. Zinc Powder	800 "
	2. Red Phosphorous	250 "
11. THIRAM	1. Carbon Disulfide	500 "
	2. Dimethyl Amine*	500 "
	3. Sod. Hydroxide	300 "
12. ZIRAM	1. Carbon Disulfide	500 "
	2. Dimethyl Amine*	250 "
	3. Zinc chloride	600 "
	4. Sod. Hydroxide	300 "
13. THIOCARBAMATE	1. Carbon disulfide	550 "
	2. Ethlene diamine*	225 "
	3. Zinc chloride	950 "
	4. Sod. Hydroxide	300 "
14. ENDRIN	1. Cyclopentadiene*	250 "
	2. Hexachlorocyclppentadiend*	800 "
	3. Vinyl chloride*	200 "
15. ALDRIN	1. Cyclo Pentadiene*	297 "
	2. Acetylene	100 "
	3. Hexachlorocyclopentadiene*	800 "
16. CHLORDANE	1. Cyclo Pentadiene*	250 "
	2. Hexachlorocyclopentadiene*	800 "
	3. Chlorine	100 "
17. TOXAPHENE	1. Camphene	400 "
	2. Chlorine	1400 "

Name of the Insecticide		Main Raw Materials	Qty. for 1 ton
18. PHORATE	1.	Phosphorous Pentasulfide	1000 Kgs.
	2.	Ethanol	400 "
	3.	Formaldehyde	200 "
	4.	Ethyl Mercaptan*	200 "
19. PHENTHOATE	1.	L.Bromo Phenyl Acetic Acid*	700 "
	2.	Ethanol	150 "
	3.	Methanol	100 "
	4.	Phos. Pentasulfide	700 "
20. TETRADIFON	1.	2,4,5-Trichloro Phenyl Sulfonyl Chloride *	1000 "
	2.	Chlorobenzene	350 "
21. DICOFOL	1.	DDT	100 "
	2.	Chlorine	100 "
	3.	Sulfuric acid	300 "
	4.	Para Toluene sulfonic acid	500 "
22. CARBAMATE		Naphthol	800 "
		Methylamine*	100 "
		Phosgene	500 "
	or	MIC	320 "
23. CARBOFURAN		MIC	290(370) "
		Catechol*	1160(2210) "
		Methallyl chloride*	950(1810) "
24. ENDOSULFAN		Hexachlorocyclopentadiene*	700 "
		1,4-Butene-Diol*	250 "
		Thionyl Chloride	300 "
25. PARAQUAT		Sodium Cyanide*	300 "
		Pyridine	970 "
		Methyl Chloride	660 "
26. FURADAN		Catechol*	2210 "
		Methyl Isocyanate	370 "
		Methallyl chloride*	1810 "
		Chloroform	2200 "
		Methyl alcohol	2000 litres
		Sodium Methoxide	1105 Kgs.
27. E. PARATHION		p-Nitrophenol*	535 "
		Phosphorus Trichloride	685 "
28. M. PARATHION		p-Nitrophenol*	670 "
		Phosphorus Trichloride	910 "
29. DIMETHOATE		Phosphorus Pentasulphide	1000 "
		Monomethyl Amine*	500 "
30. FENITROTHION		Phosphorus Trichloride	910 "
		p-Nitro Meta Cresol*	795 "
		Phosphorus Pentasulphide	700 "
31. MALATHION		Phosphorus Pentasulphide	500 "
		Maleic Anhydride*	370 "
32. METHYL DEMETON 50%Conc.		p-Nitro Meta Cresol*	1300 "
		Thio alcohol*	397 "

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* IMPORTED

ANNEXURE V

Resource requirement of foreign exchange for the import of raw materials for the production of basic chemicals

(Rs. lakhs)

Sl.No.	Items	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79
1.	Parathion	38	40	48	52	56	64
2.	Malathion	32	40	48	56	64	72
3.	Dimethoate	1.5	1.9	2.3	2.7	3.1	3.3
4.	Fenitrothion	17	30	45	60	60	60
5.	M.Systox	6.3	9	13.5	18	22.5	27
6.	Phosphamidon	56	64	72	80	80	88
7.	DDVP	5.5	8	10.5	13	15.5	19
8.	Monocrotophos	40	50	60	70	80	90
9.	Dithiocarbamates	3.5	4.8	6.1	7.4	8.7	10
10.	Thiocarbamates	20	25	30	35	40	45
11.	Organo mercurials	8.8	9.0	10.4	11.2	12	12.8
12.	Endosulfan	-	-	-	-	96	144
13.	Nickel chloride	8.4	13.2	14.4	15.6	16.8	18
14.	Weedicides	-	-	20	40	60	90
15.	Misc. Pesticides like Quinalphos, phorate etc.	-	20	30	40	50	60
	Total	237.0	315.5	410.2	501.9	664.0	803.3

ANNEXURE VI

Yearwise Requirement of Foreign Exchange for the import of Pesticides to supplement local availability

(in Rs.lakhs)

S.No.	Name	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79
1.	Endrin	240	112	88	64	40	32
2.	Aldrin/Dieldrin/Heptachlor	75	100	125	150	175	200
3.	Carbaryl	600	670	800	800	-	-
4.	Endosulfan	150	200	200	200	-	-
5.	Toxaphene	36	42	48	-	-	-
6.	Phorate/Disyston/ Thiometon/Formothion	60	90	90	90	90	90
7.	New Fungicides	105	180	210	270	315	375
8.	Acaricides	27	30	32	35	37	40
9.	Paraquat	170	270	330	330	-	-
10.	Dalapon	25	25	30	-	-	-
11.	Propanil	80	65	88	88	88	-
12.	Alachlor/Butachlor/ Trifluralin/Propachlor						
13.	Other Herbicides	40	50	60	60	60	60
14.	Plant growth regulant	14	20	40	40	40	40
15.	Misc. & New Pesticides*	75	125	200	200	250	250
	Total	1667	1979	2341	2327	1095	1087

* For details of products, refer items 5, 20, 22 and 23 of Annexure II

ANNEXURE VII

TYPES OF MATERIALS AND CAPITAL EQUIPMENT REQUIRED FOR PESTICIDES INDUSTRY

1. Stainless steel sheets and plates for fabrication of plant and machinery.

2. Stainless steel tubes, pipes, fittings both for fabrication and installation of plant and machinery.

3. Reactors glass lined, P.V.C. lined, impervious graphite or similar special materials.

4. Centrifugal lined, coated, stainless steel suitable for work in highly explosive or flame proof areas.

5. Process control instruments, gauges, including control valves, safety provisions etc.

6. Agitators complete with motors, gears made of Stainless steel or special materials.

7. All types pumps Stainless steel, P.V.C, Mild Steel, etc.

8. Service equipments, refrigeration, boilers, water treatment, effluent treatment etc.

9. Electrical transformers and fittings.

10. Misc. like dryers, fitterpress etc.

11. Grinding equipment like hammer and air attrition mills, micropulverisers etc.

12. Mixing equipments like Blenders etc.

13. Granulating equipments.

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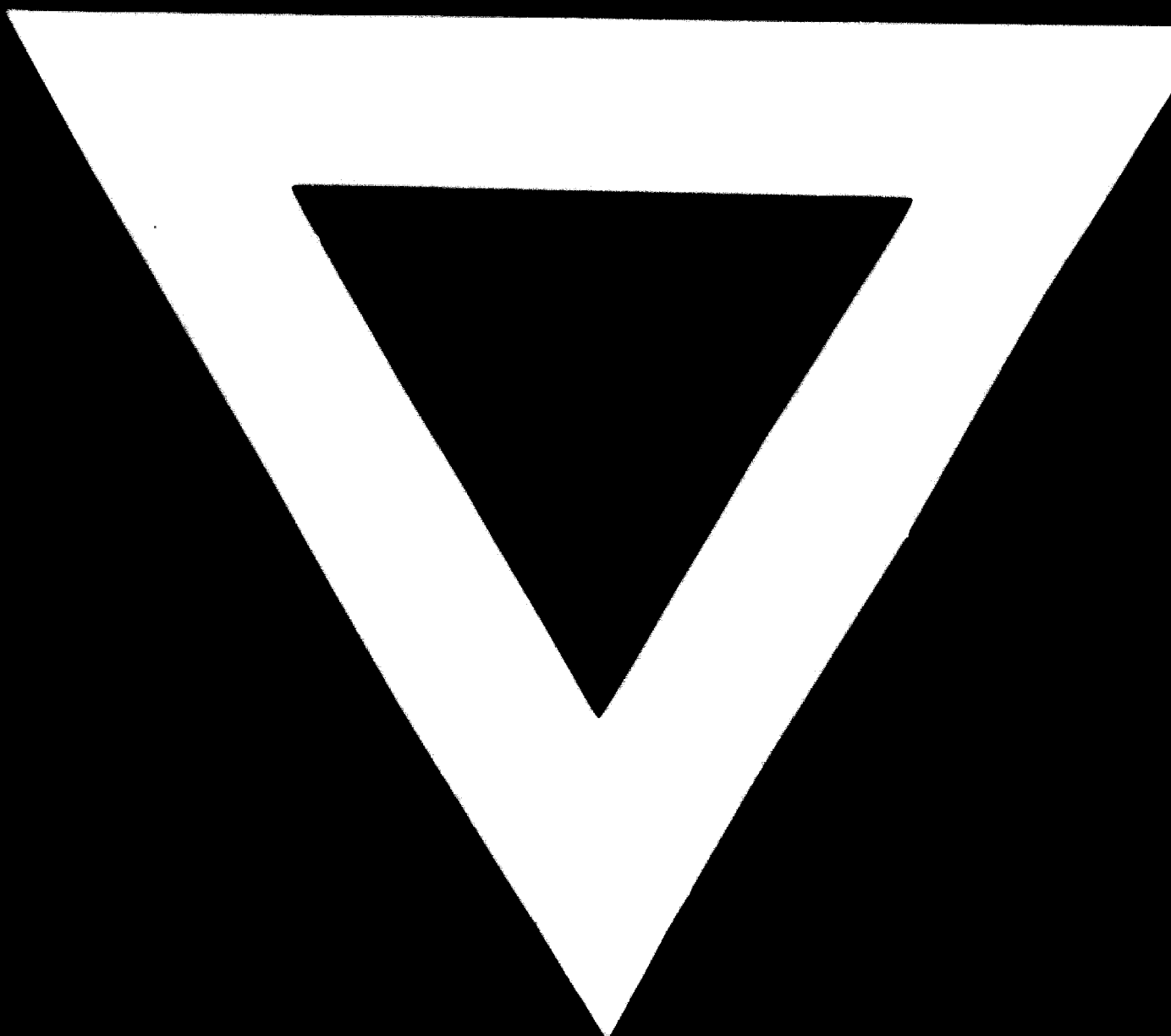
ANNEXURE VIII

[redacted]

Name of Product	Economic Plant size (tonnes)	Total cost (Rs. million)	Unit cost/ tonne	Estimated product requirement and additional investment needed- 1978-79			
				Estimated demand 1978-79 (tonnes)	Estimated investment (Rs.million) Indi.	Impt.	Total
Carbaryl	5,000	50.0	10,000	8,500	45	40	85
Endosulfan	1,200	60.0	50,000	1,800	60	30	90
Malathion	500	12.0	24,000	3,500	36	12	48
Other O.P's e.g. Parathion, Metasystox, Fenitrothion, Phosphamidon, DDVP, Monocrotophos etc.	2,100	52.5	25,000	4,000	55	45	100
Toxaphene	500	5.0	10,000	1,200	10	2	12
Paraquat	500	21.6	43,200	500	16.6	5	21.6
Other Herbicides	1,000	10.0	10,000	3,000	12	18	30
					234	152*	386.6

* Foreign Exchange



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